Food System Economics Commission

WORKING PAPER

Regional Analysis of Hidden Costs of the Food System Economic Commission Current Trends and Food System Transformation Pathways to 2050: Brazil Key Figures

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Background Brief for the
Food System Economic Commission

Regional analysis of hidden costs of the Food System Economic Commission current trends and food system transformation pathways to 2050: Brazil Key Figures

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Key figures

Current hidden costs. Annual Brazil greenhouse gas (GHG) emissions, nitrogen (N) pollution, and habitat losses and returns from land-use change from food production, and productivity losses from consumption of unhealthy diets, have current hidden costs of 500 billion USD 2020 PPP (Figure 1S)

What are hidden costs? Food production and food consumption in the current year create costs that will be borne in the near- and long-term future. Indicators such as gross product count the value-add of current activities in purchasing power terms but do not account for the future deficits, this is why the costs are hidden from national accounts and not factored into current markets.

Perspective on economic burden of hidden costs. Roughly, corrected for the purchasing power denied to future economies from hidden costs, Brazil's GDP would be 16% lower (500 billion USD 2020 PPP is 16% of Brazil's 2020 GDP in purchasing power terms). The correction exceeds the gross product from value-add of agriculture, forestry, and fishing (~6% in 2020).

Accumulating deficit. Unlike a shock such as the global financial crises or the COVID-19 global pandemic, the food system produces costs year on year. The hidden deficit accumulates in real terms and poses economic risk to Brazil, especially economic activity with a natural capital base.

Reduction of deficit by transforming food systems. The Food System Economic Commission (FSEC) Food System Transformation (FST) pathway assumes fundamental changes in food production and food consumption between 2020 and 2050. Over this period the FST would reduce accumulated Brazil food system hidden costs over 2020 to 2050 by 51% (Figure 1S top panel). The magnitude and composition of the avoided hidden costs changes over the period 2020 to 2050 as the measures in FST are implemented and responded to, but averaged the avoided hidden costs amount to 216 billion USD PPP per year (Figure 2S bottom panel and Figure 3S middle panel). The cost reduction increases over the period (Figure 1S bottom panel Figure 3S right panel). By 2050 the annual costs are converted from a 315 billion USD 2020 PPP deficit produced in the baseline scenario in 2050 to 54 billion USD 2020 PPP in benefits under FST.

Confidence in benefits increases over the period. Brazil has a high share of land surface utilised for agriculture. Brazil is one of the world's major food exporters, and agricultural activity ranges from maize and soy cereals, to horticulture, forestry, coffee and cocoa bean production, livestock grazing, and intense poultry production. FST measures for agriculture such as habitat sparing for biodiversity intactness, payment of nitrogen mitigation measures, payment for carbon sequestration, and changes in global demand through dietary changes, produces large flux in land-use. The FSEC hidden cost analysis includes large uncertainty in environmental prices for GHG pollution, N pollution, and lost or returning ecosystem services. Combining the flux in land-use with uncertainty in the marginal costs such as carbon sequestration versus livestock methane production, produces large uncertainty ranges for the avoided hidden costs over the period 2020-2050 where restructuring of land-use occurs (Figure 1S bottom panel). By 2050 there is increasing confidence that avoided costs from the FST transition will exceed 80 billion USD PPP per year by 2050 (Figure 1S bottom panel and Figure 2S third from bottom panel), and a 20% chance of exceeding 500 billion USD PPP per year. The avoided hidden costs from implementing FST are increasing in 2050 and likely continue to grow after 2050.

Composition of avoided costs under food system transformation. Averaged over the period 2020 to 2050, avoided cropland expansion and forest habitat return (74 billion USD 2020 PPP per year), carbon sequestration and CH4 mitigation (47 billion USD 2020 PPP per year), and avoided nitrogen run-off (44 billion USD 2020 PPP per year) are the largest avoided costs under FST (Figure 3S middle

panel). For Brazil the avoided costs from food production are larger than the productivity gains from healthier diets (40 billion USD 2020 PPP per year) (Figure 3S middle panel).

Economic costs of degrading blue water resources. Impacts of water scarcity are endogenous to the land-use partial equilibrium model utilised by FSEC, so impacts on agricultural production and undernutrition of water scarcity factor into land-use and body mass index calculations. Lost ecosystem services from loss of environmental flows due to degraded blue water resources are not counted in the hidden cost figures.

Trends of costs over the period 2020 to 2050. Contributions to the difference costs and benefits between FST and the baseline scenario CT are not constant over the period 2020 to 2050. Avoided cropland expansion and an increase in forest habitat returns and carbon sequestration under FST occurs in earlier decades. Savings from mitigating nitrogen surplus (66 billion USD 2020 PPP) and healthier diets (78 billion USD 2020 PPP) are main category of savings as well as the main residual costs by 2050 (Figure 3S right panel). Ecosystem services from forest habitat returns become the main benefits to the Brazil economy after 2050 under FST compared to CT (189 billion USD 2020 PPP). Land-sparing is due to diverging input efficiency and global dietary demand between FST and the baseline scenario. Mitigated CH4 due to reduced livestock production and improved practices is a component of the avoided GHG damages, but carbon sequestration becomes the major component (34 billion USD 2020 PPP annually on average). On the consumption side, transition to healthy diets is introduced linearly over the period, consequently labour productivity improvements increase over the period from a proportion of 13% of avoided costs in 2030 (27 billion USD 2020 PPP) to 21% in 2050 (78 billion USD 2020 PPP) (Figure 3S right panel).

Poverty. Poverty decreases steadily over the period in line with economic growth. The economic and demographic growth forecast used for the FSEC analysis needs to be long-term to apply appropriate discounting to the hidden costs which are diffused into cost-bearing in future economies. Economic and population growth under IPCC shared socio-economic pathway 2 (SSP2) was used.

Trends in economic risk. Economic risk from uncertain costs of GHG emissions, nitrogen surplus and lost ecosystem services decrease under FST. The 95-th percentile of production hidden costs reduces from 410 billion USD PPP in 2050 under the baseline scenario to 33 billion USD 2020 PPP in FST (Figure 6S left and middle panel). In fact, the skew of the distribution of costs changes by 2050 from risk of environmental costs under CT to potential benefits under FST. Ecosystem services from the return of forest habitat and carbon sequestration indicate a potential for high benefits to Brazil's economy in the second half of the 21st century under FST, where residual nitrate run-off under CT is responsible for a risk of high environmental costs (Figure 6S right panel).

Comparison with other regions. Avoiding a western-style trajectory of obesity and overconsumption of sugars, salt, and processed foods is one of the main global economic benefits of FST (Figure 5S), however, for Brazil, environmental costs and benefits have a more significant role. Nitrogen surplus mitigation and avoided cropland expansion in Brazil, China and India are major global benefits under FST. The largest global environmental benefits under FST to 2050 come from Brazil, followed by Latin America. Globally, changing agricultural practices and avoiding deforestation in Sub-Saharan Africa as food production expands and intensifies is also a major global benefit, to which Brazil as an economy that has sustained continued growth in productivity and value from agricultural activity could make a major contribution exporting technology, expertise, and inputs.

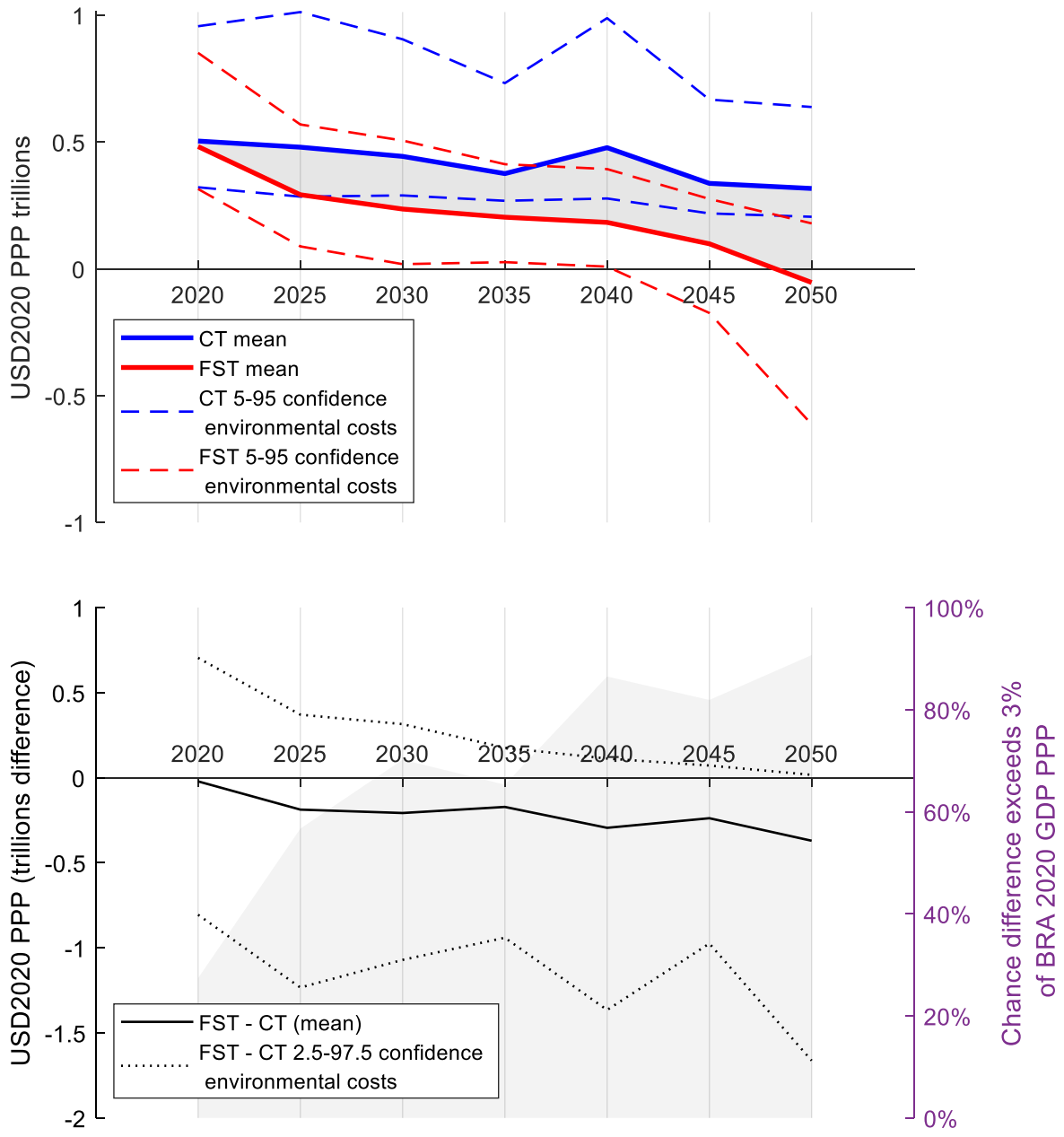

Figure 1S: Trajectory of Brazil total annual hidden costs and cost reduction for CT and FST in 2020 USD PPP. Top panel shows the total expected hidden costs under CT (blue) and FST (red). The shaded area between the trajectories indicates the mean value of the total reduction under FST over the period 2020-2050 in 2020 USD PPP. Trajectories of the 5-th and 95-th percentiles of the respective distributions of Brazil hidden cost are shown, accounting for uncertainty in the production costs (greenhouse gas (GHG) and reactive nitrogen (N) emissions, lost habitat from land use changes and returned habitat from abandoned agricultural land). Even with high uncertainty in environmental costs the bottom panel shows that hidden cost reduction under FST is very likely (>97.5%) by 2050 with an increasing probability that the reduction in annual costs produced exceeds 3% of Brazil's 2020 GDP PPP.

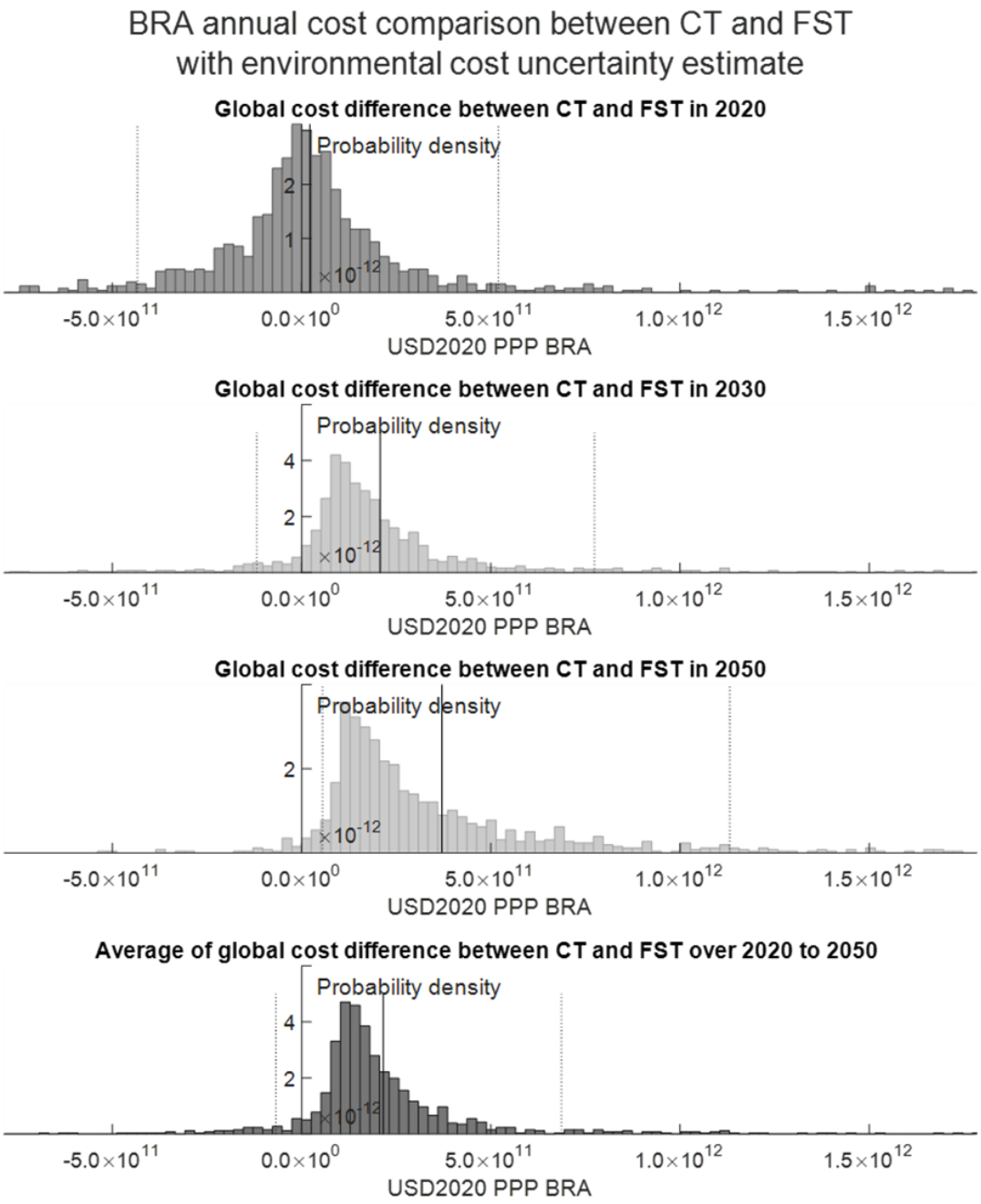

Figure 2S: Distribution of Brazil total annual hidden cost reduction under FST in 2020 USD PPP in 2020, 2030 and 2050. Hidden cost reduction can be examined with uncertainty in environment costs in the FSEC study. Figure 1S bottom panel showed the trajectory of the mean and the 2.5-th and 97.5-th percentile statistics of the distributions of Brazil annual hidden cost reduction under FST. The top, second to top, and second to bottom panels in this Figure show cross-sections of the full distribution of Brazil's annual hidden costs reduction in the years 2020, 2030 and 2050. The bottom panel shows the distribution of the total cost reduction divided by the 30 year period (average annual cost reduction). The conclusions that FST reduces hidden costs by 2050, that average annual hidden cost reduction under FST exceeds 80 billion USD 2020 PPP, are robust to the modelled uncertainty in the marginal costs of GHG, N emissions, and ecosystem services.

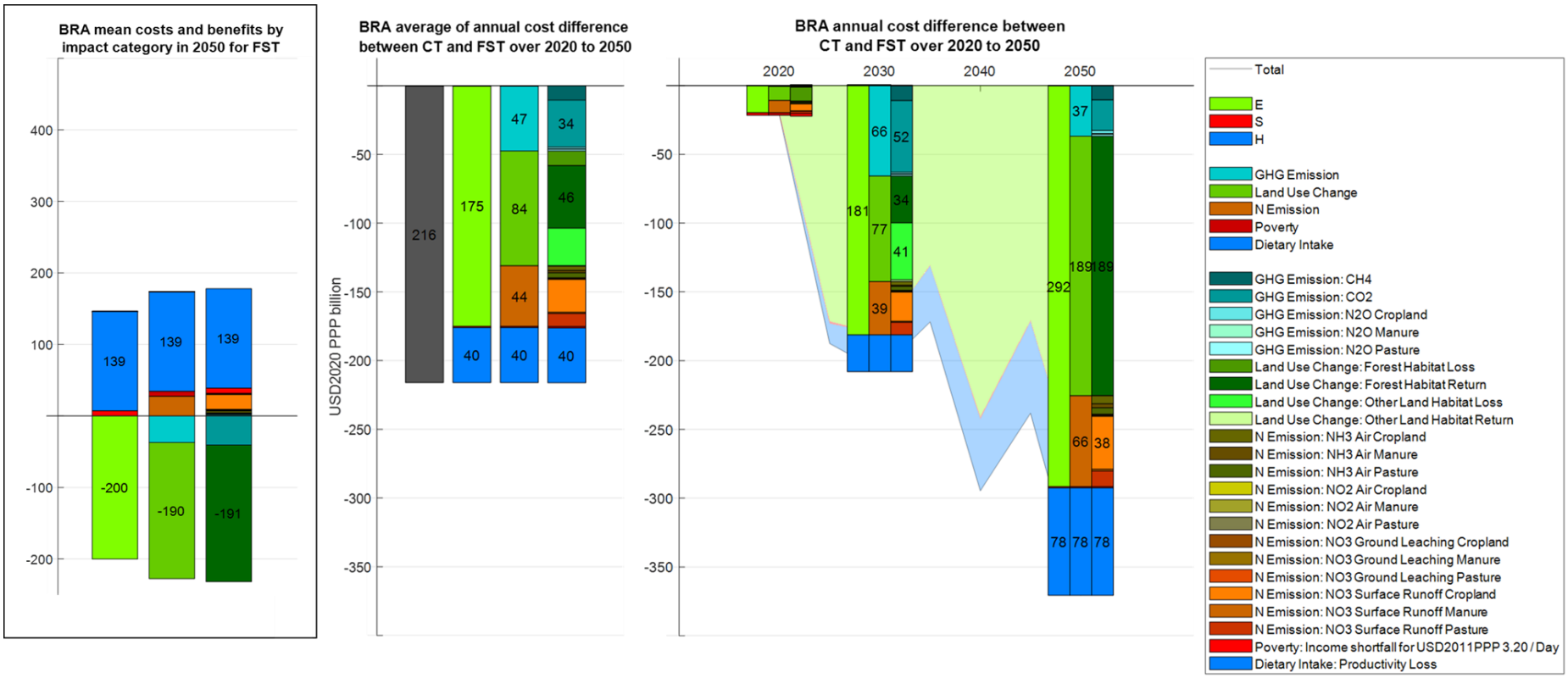

Figure 3S: Breakdown of Brazil annual hidden cost reduction under FST compared to CT in 2020 USD PPP in 2020, 2030 and 2050. Large average hidden cost reductions under FST over 2020-2050 come from ecosystem services from returning forest habitat, carbon sequestration, mitigating NO3- run-off from cropland, and productivity gains from lowering burden of disease from food consumption (middle panel). For Brazil, benefit from sequestration and additional forest regeneration under exceeds the productivity gains for healthier diets, both on average (middle panel) and over the period 2020-2050 (right panel). Up to uncertainty in production costs, GHG emission reduction through CH4 mitigation but primarily carbon sequestration, and reduction in N pollution, provide equal contribution to hidden cost reduction over the period 2020-2050 (middle panel). Sequestration from measures under FST implemented in 2025 has larger benefits earlier in the period (52 billion 2020 USD PPP in 2030) compared to nitrogen mitigation, while reduction in N pollution contributes more later in the period 2020-2050 (38 billion 2020 USD PPP in 2050) (right panel). Benefits from avoided cropland expansion occur earlier in the period under FST, while agricultural land-spared from global and domestic dietary change and efficiency improvements under FST results in increasing benefits of returning forest habitat compared to CT by 2050. Residual hidden costs and benefits by 2050 under the FST trajectory are predominately productivity losses from food consumption, with benefits from carbon sequestration and returning forest habitat (left panel).

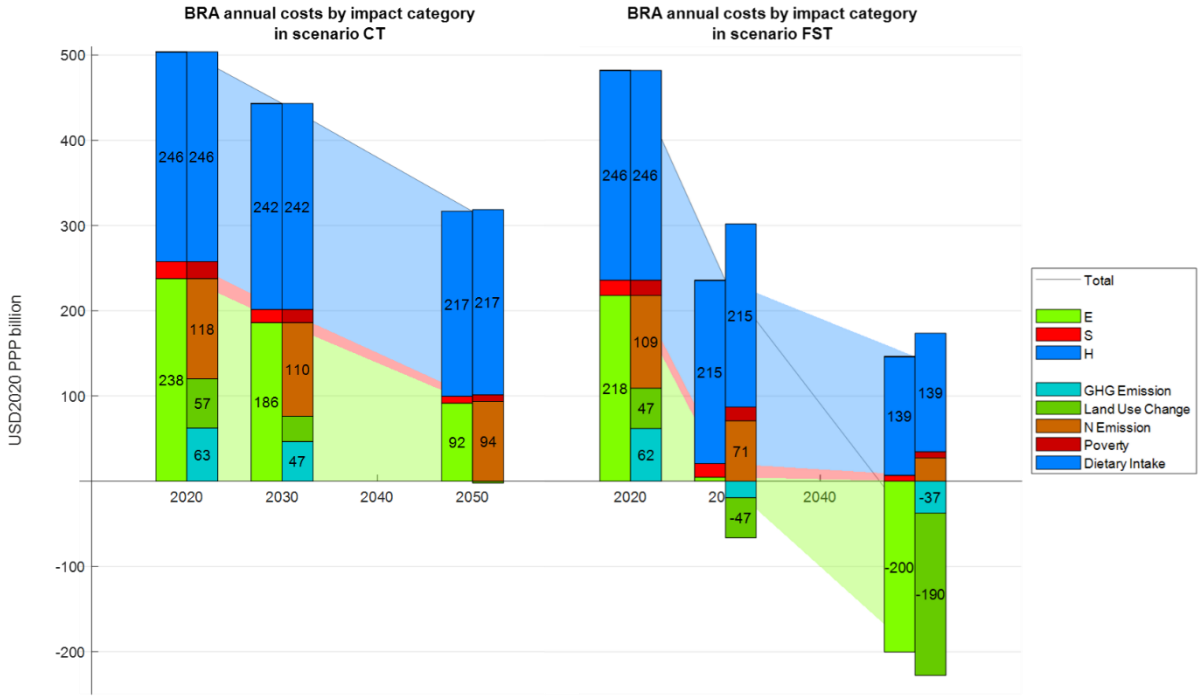

Figure 4S: Transition of production away from hidden costs and avoided western-style disease burdens and costs from unhealthy diets in annual hidden cost reduction under FST in 2020, 2030 and 2050 for Brazil (BRA). As a complement to Figure 3S, this Figure shows cost reduction in its context of changes in total hidden costs. Current hidden costs arise from productivity losses (blue) from consumption, nitrogen pollution from food production (brown), loss of natural habitats from agricultural land expansion (green) and food system GHG emissions (cyan). Economic burden from consequences of food production (light green) under the baseline CT scenario are averted and reversed under FST. For GHG and land-use change, the baseline CT scenario has a cost neutral profile by 2050, with ecosystem services from habitat return balancing costs of habitat loss, and benefits of carbon sequestration of a similar size to cost of CH4. Under FST large costs of agricultural N pollution are voided, and forest habitat return and carbon sequestration are providing large benefits. Poverty reduction largely follows general economic development of other sectors and is not largely changed by the FST measures.

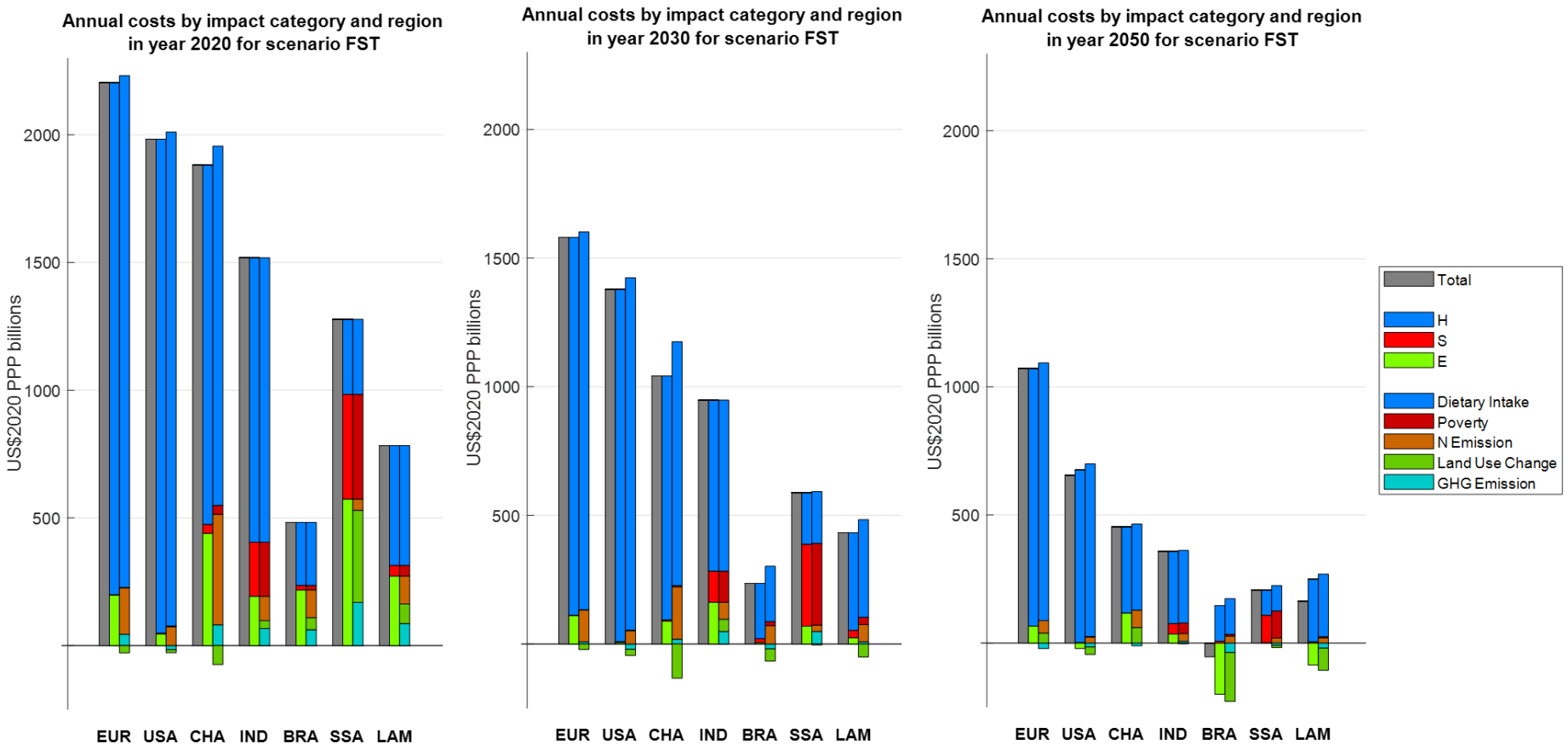

Figure 5S: Comparison of annual hidden costs under FST in 2020 USD PPP in 2020, 2030 and 2050 for 7 FSEC regions. Regional trajectories show transitions in productivity loss from diets and N pollution globally, global GHG cost neutrality for many regions from balancing CH4 emissions and CO2 sequestration, land-use change in Brazil (BRA), Latin America (LAM), and Sub Sahara Africa (SSA), and residual poverty in IND and SSA under SSP2.

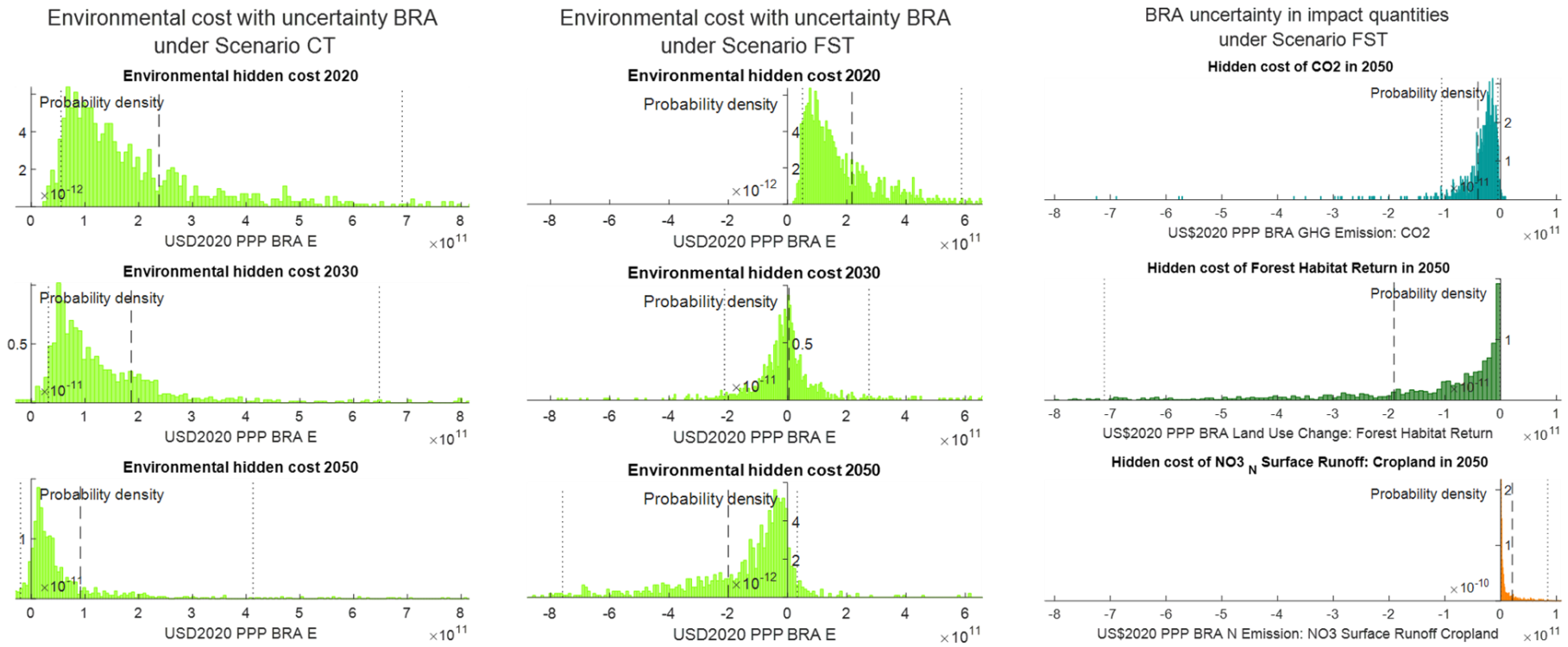

Figure 6S: Distribution of production annual hidden cost reduction under FST in 2020, 2030 and 2050 for Brazil (BRA). Figure 1S top panel shows a wide uncertainty band of hidden costs under CT and FST coming from the uncertain marginal costs of greenhouse gases, value of ecosystem services, and impact from nitrogen surpluses along the nitrogen cascade. Left panel shows the distribution of environmental hidden cost in 2020, 2030 and 2050 under the baseline scenario CT, which transitions from a right skew and a long-tail of risk of higher hidden costs to a left-skew toward opportunity for higher benefits in 2050 under FST in the middle panel. Uncertainty in the residual hidden costs of production under FST in 2050 resides mainly in two benefits items (CO2 sequestration and ecosystem services from return of forest habitat) and the cost item of nitrate run-off from croplands, see right panel. Figure 1S bottom panel and Figure 2S show high uncertain for the cost difference distribution between FST and CT, which is primarily two-sided fat tails driven by uncertainty in the ecosystem values from habitat losses and returns. Return of forest habitat and CO2 sequestration are the main sources of uncertainty in the transition from risk of costs to benefits.